

Collaborative Research: Characterization and Modeling of the Philippines Strait Dynamics Using the ROMS 4DVAR Data Assimilation System

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LONG-TERM GOALS

The goal of this project is to provide a comprehensive understanding of the remote and local factors that control the meso- and submesoscale features in and around the Philippines Strait region. The primary tool to be used is a nested grid implementation of ROMS in conjunction with advanced data assimilation techniques and adjoint-based methods of sensitivity analysis. The ultimate goal of the project is to improve our capability to predict the inherent spatial and temporal variability near the Straits, and thus contribute to the development of reliable prediction systems.

OBJECTIVES

The objectives to accomplish the goal are: (1) to explore the effects on the Philippines Straits circulation of remote forcing from the equatorial waveguide of the Pacific Ocean, which have large amplitude variations on intraseasonal, seasonal, and interannual timescales (dominated by ENSO); (2) to estimate the effects of local winds in the Philippines Sea region in generating meso- and submesoscale variability in and around the Philippines Straits; (3) to quantify the role of barotropic tidal forcing in promoting side wall eddies and internal tides; (4) to examine the role of abrupt changes in bathymetry in generating submesoscale variability; and (5) to investigate the impact of data assimilation on the simulation and predictability of the meso- and submesoscale circulation features.

APPROACH

The approach for accomplishing the proposed project goals is model simulation using ROMS (Shchepetkin and McWilliams 2005) and its comprehensive ocean prediction and analysis system (Moore et al. 2004). Tidal forcing will be imposed using available tidal models (e.g., Egbert and Ray 2000, 2001).

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The role of the CU PI, Weiqing Han, is to assist the Rutgers PIs to design the ROMS experiments that isolate remote versus local processes, verify the model forcing fields and interpret the model results.

WORK COMPLETED

Two ROMS runs for the Philippines Sea region for the period of 2004-2006 have been completed: one with lateral boundary conditions from the daily global $1/12^\circ$ resolution HYCOM, and the other with the 3-year-mean HYCOM solution that excluded variability at the lateral boundaries from the equatorial waveguide and South China Sea. These two experiments intended to estimate remote versus local influences on the meso- and submesoscale circulations in and around the Philippines Straits, as stated in Objectives (1) and (2).

RESULTS

a). Validation of ROMS Forcing Winds.

The CU PI accomplished the validation of the ROMS forcing winds, which are the 3-hourly NOGAPS winds, by comparing the NOGAPS and QuikSCAT satellite winds. To ensure “independence” of the two datasets, comparison was made before 12Z of November 10, 2004, a time when NOGAPS began to assimilate QuikSCAT winds (Dr. T. Hogan, person. comu., 2007; https://www.fnmoc.navy.mil/PUBLIC/QC/CVRG/index_java_script.html). The $0.5^\circ \times 0.5^\circ$ 3-hourly NOGAPS wind fields are compared with the COAPS $1^\circ \times 1^\circ$ QuikSCAT 6-hourly pseudo wind stress for the periods of 2004-2006. The QuikSCAT U and V components are calculated from the pseudo wind stress before the comparison. The region shown in the figures below is the ROMS coarser resolution (5km) model domain in the western pacific, which covers the Philippines seas and straits. NCEP/NCAR reanalysis winds on Gaussian grids are also used for the comparison. All the winds are at the 10m level. Below are some specific examples for the comparison.

In general, NOGAPS and QuikSCAT winds have similar large-scale wind structure and comparable amplitudes, such as the easterly and southeasterly winds south of the equator in Fig. 1. A strong cycle west of Luzon Strait develops from 0hour to 12hour (Figs 1-3) are shown in both wind products, except that the NOGAPS winds appear to be much stronger. This quantitative difference could result partly from the lack of information from the 6-hourly QuikSCAT data, because QuikSCAT satellite only covers 90% of the Earth within 24 hours. Within the South China Sea and the Philippines Seas, QuikSCAT winds appear to be weaker. In addition to the possibility that the NOGAPS winds are too strong, the difference could also be due partly to the lack of information and adjacency to the Islands of the 6-hourly QuikSCAT winds. The $2.5^\circ \times 2.5^\circ$ NCEP reanalysis winds are too coarse to resolve smaller scale features. Figs. 4-6 shows the comparisons on July 15, 2004.

b) What Was Learned

The NOGAPS winds are reasonable to use as forcing fields of the ROMS in the Philippines Sea region. There are, however, quantitative differences between NOGAPS and observed winds in the region. This should be kept in mind when we interpret the ROMS model results by comparing them with in situ observations.

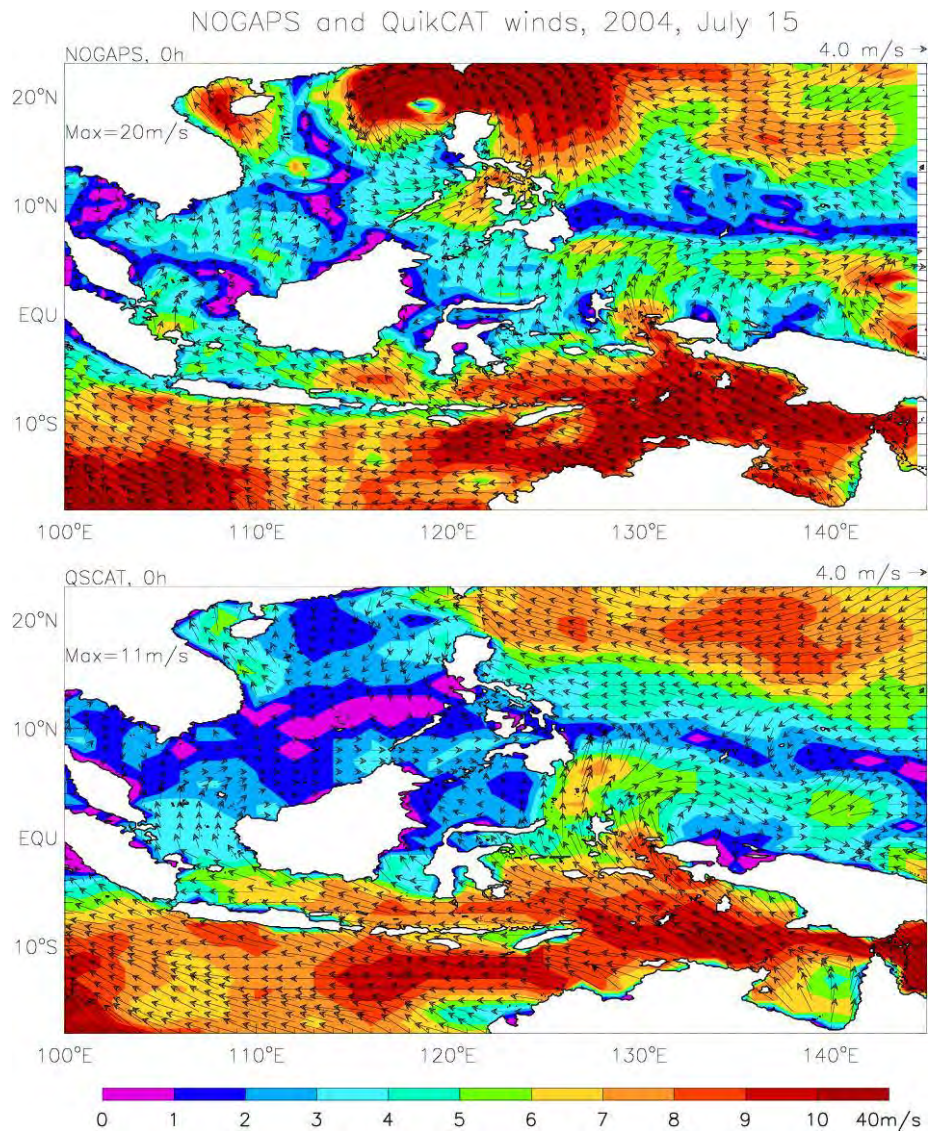


Fig. 1. Comparison between NOGAPS 3-hourly winds (top) and QuikSCAT 6 hourly winds (bottom; downloaded from <http://coaps.fsu.edu/scatterometry/>) at 0Z July 15, 2004. Wind speeds are contoured in color contours, overlying on which are wind vectors. In addition to the large-scale agreements between the two datasets, a cyclone that appears in NOGAPS winds west of the Luzon Strait also appears in QuikSCAT winds with a much weaker strength.

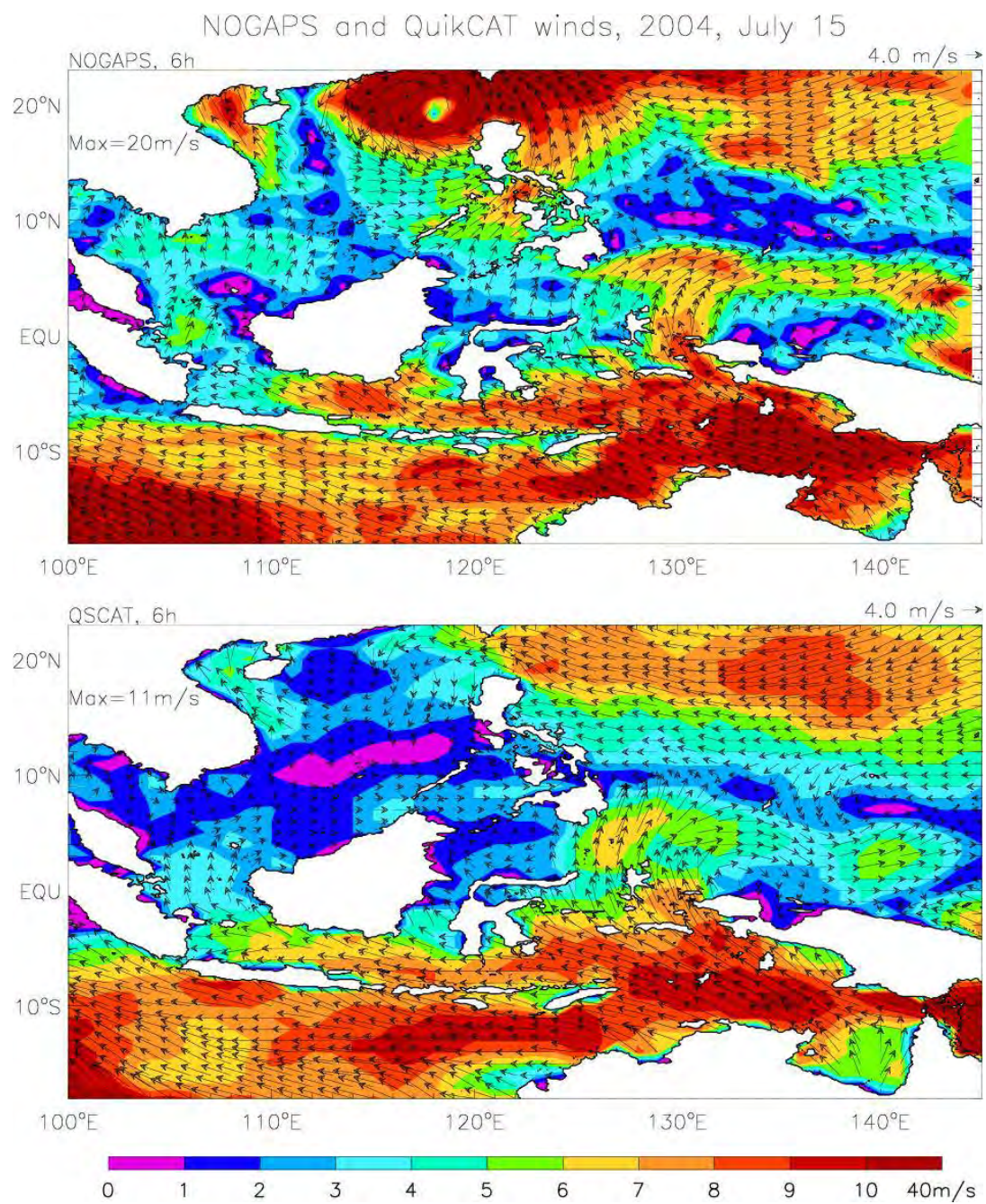


Fig. 2. Same as Fig. 1 except for 6 hours later.

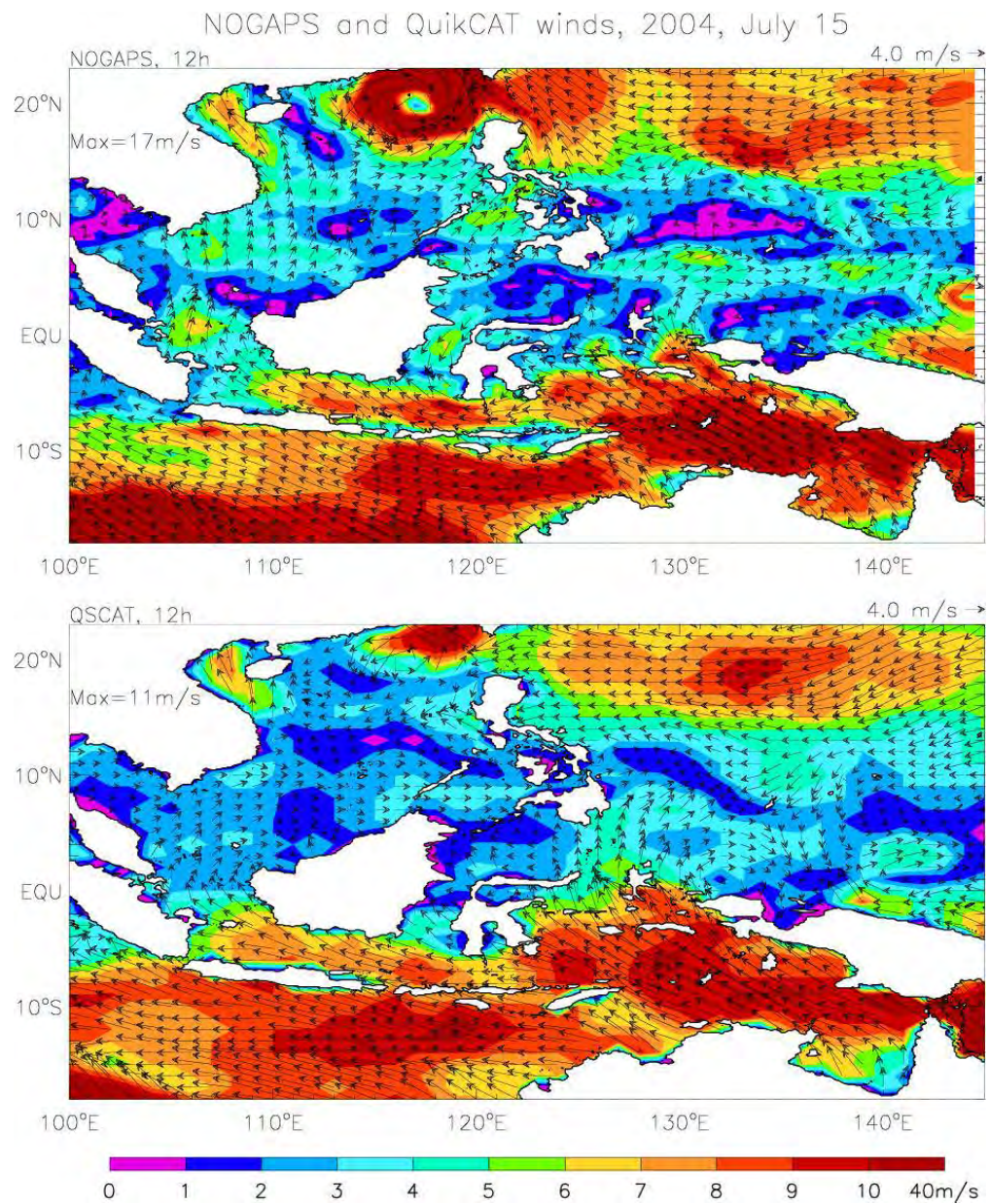


Fig. 3. Same as Fig. 1 except for 12 hours later. The strong Storm west of Luzon gains its strength both in NOGAPS and QuikSCAT winds.

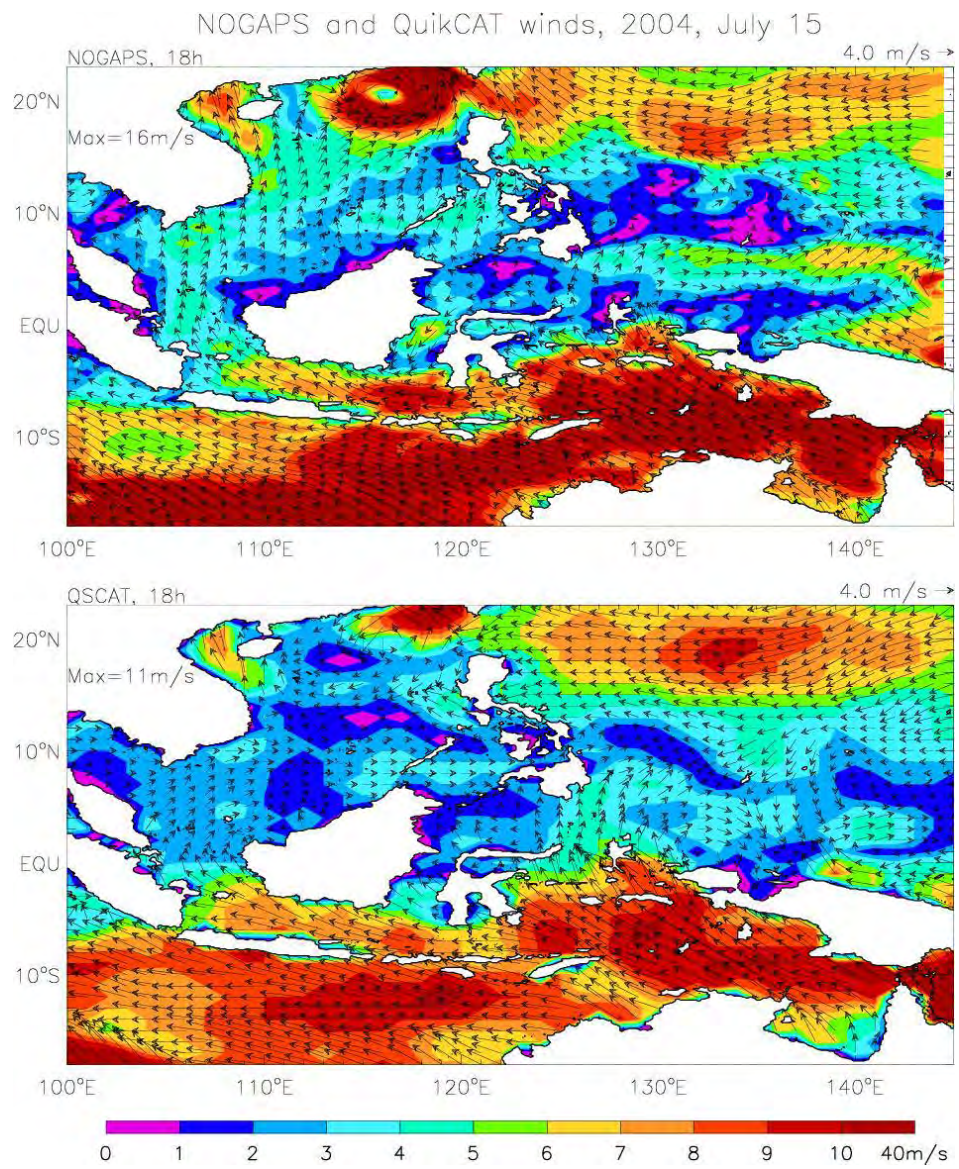


Fig. 4. Same as Fig. 1 except for 18h.

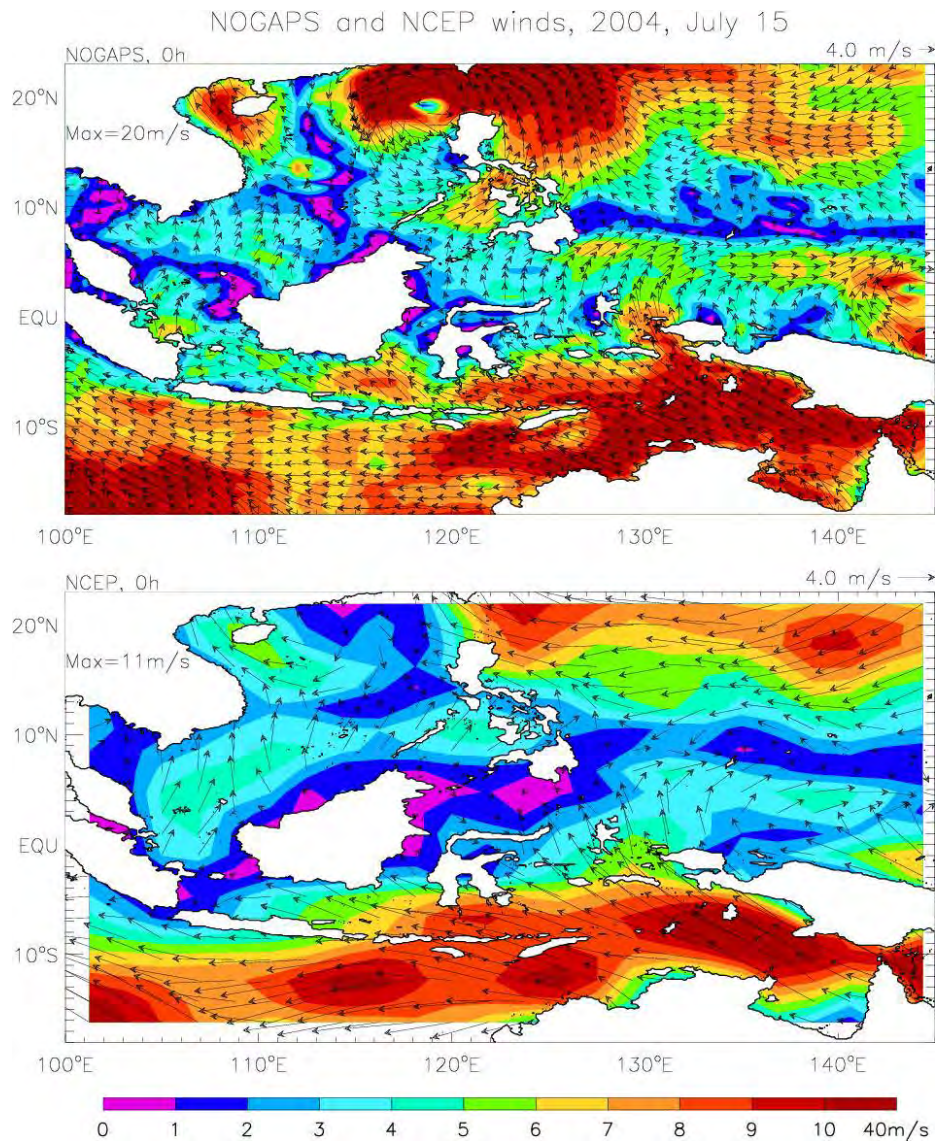


Fig. 5. Same as Fig. 1 except for NOGAP winds versus NCEP reanalysis winds at 0h on July 15, 2004. The strong cyclone west of Luzon is completely missed in NCEP winds.

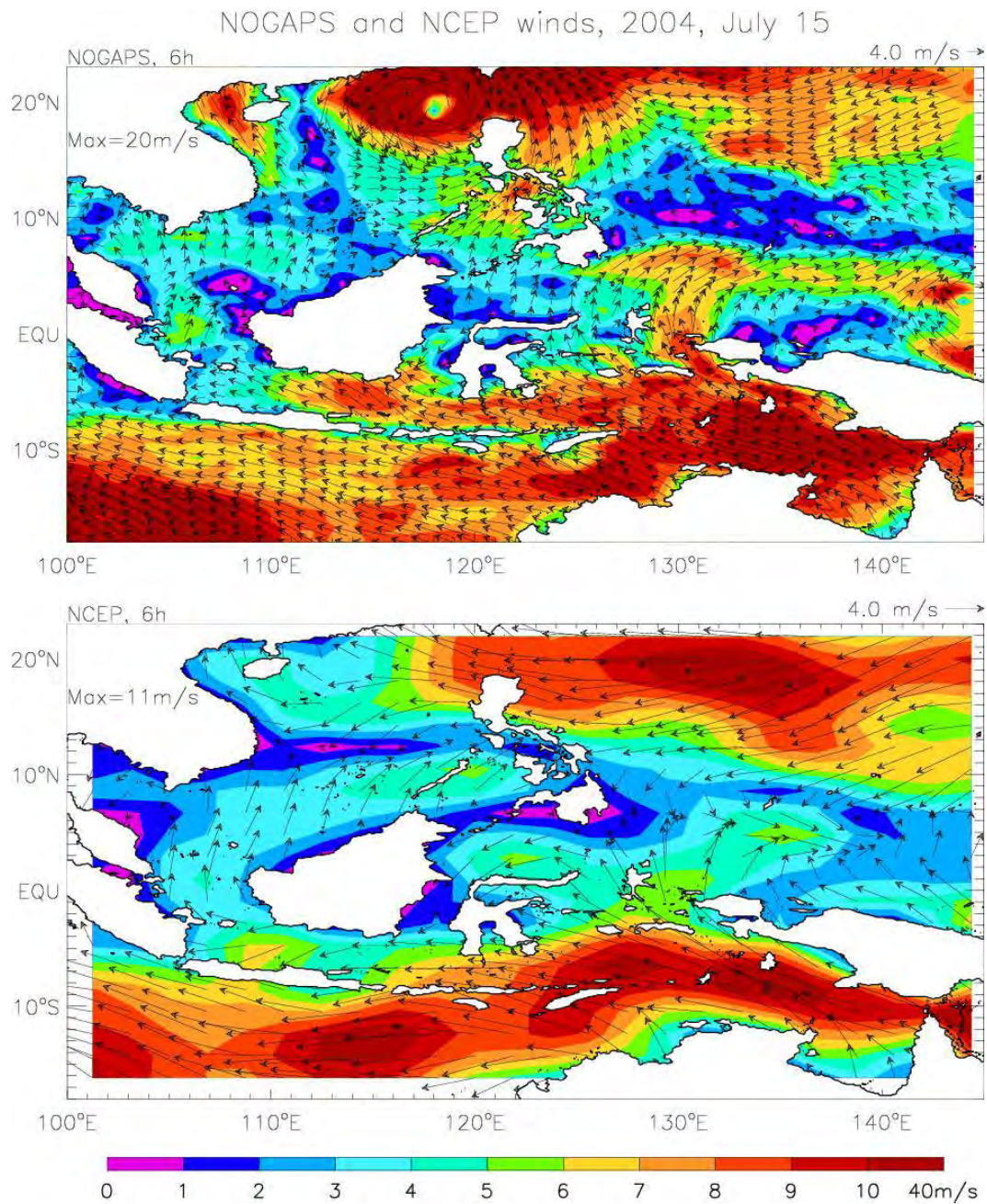


Fig. 6. Same as Fig. 5 except at 6h.

IMPACT/APPLICATIONS

The proposed project is important both scientifically and operationally, because the idea of large-scale control of the meso- and submesoscale features in the Philippines Strait region by the equatorial waveguide is new; via interaction of the circulation with abruptly changing bottom topography and tidal forcing, the waveguides may exert a significant influence on the predictability of the variability. The project will contribute to the prediction and predictability of meso- and submesoscale eddies near the straits, and directly contribute to the Navy's operational requirement.

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